IV. *The Larva of* Collyris emarginatus, Dej. By R. Shelford, M.A., F.L.S.

[Read March 6th, 1907.]

Plate III.

In Dec. 1905 I exhibited before this Society some specimens of the wood-boring larva of the Tiger-beetle *Collyris emarginatus*, Dej., and made some remarks thereon, which are published in the Proceedings of date Dec. 6th, 1905. It is to Dr. J. C. Koningsberger of the Zoological Museum at Buitenzorg, Java, that we owe the discovery of this very interesting larva. From a brief description of its habits published in "Mededeelingen uit'Slands Plantentuin," vol. xliv, p. 113, 1901, we learn that the larva excavates a burrow in the twigs of coffee-shrubs and that it feeds on the ants and aphides which crawl over the entry to the burrow; pupation takes place in the burrow. No adequate figure of the larva and no account of its external features have yet been published, but I am now enabled to supply some information on these points, thanks to Dr. Koningsberger, who has most kindly sent me two consignments of larvæ. I gladly seize this opportunity of recording my gratitude to my generous correspondent.

The burrows occupied by the larvæ of *Collyris emarginatus* are situated in the central pith of twigs of not more than 5 mm. in diameter; the woody part of the twig does not appear to be attacked at all. The burrow is generally half as long again as the larva occupying it, so that there is room for to-and-fro movements of the occupant. Close to the anterior end of the burrow is a small circular orifice passing through the woody tissue of the twig and placing the burrow in communication with the outer world; the outer margin of this orifice is raised, so that the entry to the burrow appears to be countersunk. This raised margin is brought about by the swelling of the bark of the twig at this point, — a pathological result of its puncture.

Though the oviposition of this Cicindelid has not been actually observed, there can be little doubt but that the adult female perforates the woody tissue of the twig and deposits her egg in the central core of spongy pith. The larva has no organs adapted for boring through wood; the mouth-parts are not very different from those of the larvæ of *Cicindela* spp., the legs are modified merely for burrowing in relatively soft and non-resisting substances, and may well be compared with the legs of Coprid and Passalid beetles, of *Gryllotalpa* and of Panesthiid cockroaches. As already stated, the burrows are made in the centre of twigs and the woody tissue of the twigs is not attacked; the larva on hatching out from the egg has merely to dig out the soft pith of the twig in order to form for itself a cylindrical burrow, and we may presume that the *débris* is expelled from the mouth of the burrow.

As is well known, the adult females of all species of *Collyris* are furnished with a complex genital armature, which, however, has never been really adequately figured or described. If a dried specimen of *C. emarginatus* be examined with a simple lens the gonapophyses appear to consist of a pair of strongly chitinised *crotchets* projecting beyond the last visible tergite and of a pair of short down-curved spines projecting beyond the last visible sternite. Each crotchet is made up of three stout hooks directed upwards and of a much smaller hook; in some specimens these hooks project considerably, in others they are withdrawn almost entirely into the abdominal cavity. When the dorsal integument is removed, it will be seen that the crotchets and spines are attached to a chitinous tube occupying the greater part of the abdominal cavity of the last three segments. The whole apparatus can be removed bodily from the insect and after boiling in caustic potash mounted and examined under the microscope, when it will be seen that the chitinous tube is a segmented structure (Plate III, fig. 8), the number of the segments being apparently four. I have not been able to make out in the first (*i. e.* the most proximal) segment the number of sclerites composing it, but the second segment is made up of two lateral sclerites which meet each other in the mid-dorsal and mid-ventral line, also of a large spoon-shaped sclerite which embraces the ventral half of this and the succeeding segments, runs backwards to the tip of the abdomen and bears on its posterior margin the two

short decurved spines that have already been mentioned.* The third segment is composed of the lateral sclerites, and a median dorsal sclerite, which runs backward and ends between the base of the crotchets (Plate III, fig. 9. *d*); the lateral sclerites meet each other in the mid-ventral line. The fourth segment is open ventrally, the lateral sclerites are now pillars bearing the crotchets and each has a small hook on the outer aspect, the dorsal sclerites are represented perhaps by a pair of oval setigerous plates (Plate III, fig. 9. *s.p.*) covering the base of the crotchets. Each crotchet consists of three strong curved hooks, the second of which has on the ventral aspect an inwardly projecting flange (Plate III, fig. 10.*f.*); they are articulated to the lateral sclerites by a transverse joint but, so far as I know, are not movable independently of the chitinous tube. This is all that can be made out from an examination of dried specimens and I am unable to afford any information as to the exact relations of these parts to the other internal organs of the beetle. But there can be no reasonable doubt that the segmented chitinous tube is composed of retracted terminal segments, the last one of which bears appendages in the form of crotchets, and it is these appendages only which can be regarded as the morphological equivalents of the female gonapophyses of the Terebrant Hymenoptera. The *modus operandi* of the genital armature of *Collyris* is obscure, but I have little doubt of its efficiency as an instrument for boring through wood of no greater hardness than young coffee twigs. Strictly homologous organs occur in other Cicindelidæ and doubtless in every case they function as boring tools. So far as is known—though observations on the subject are woefully inadequate—the Cicindelidæ deposit their eggs *in* substances, and not *on* surfaces, and it does not require a great stretch of imagination to suppose that the arboreal *Collyris* only departs from the habits of its allies so far as to deposit her eggs inside the twigs of trees and shrubs. It is of interest to note that the pair of decurved ventral spines are only well-developed in the arboreal species,†

* These spines have been described elsewhere as attached to the last visible sternite, but this is manifestly incorrect.

† Wallace states that *Therates labiata* in Amboina is arboreal and in this species the ventral spines are well developed; in other species that I have examined these spines are minute or absent, and Canon Fowler informs me that occasionally they are modified to form comb-

and I would suggest that in the case of *Collyris* at any rate they function as guides for the passage of the egg through the aperture bored in the woody tissue of the twig. Species of *Cicindela*, to take an example, would have presumably no difficulty in depositing their eggs in the burrows excavated for their reception; the burrow is of sufficient diameter to admit the tip of the abdomen and the egg can be simply dropped before the tip of the abdomen is withdrawn after the operation of excavation. The entrance to the burrow occupied by the larva of *Collyris emarginatus* is not large enough to admit the tip of the abdomen of the adult female, as can be shown by measurements, but the two ventral spines fit into it with ease. Without these spines it is difficult to see how the female *Collyris* could be certain of passing her egg through the aperture in the wood which she has made; she would be liable to deposit it rather on the outer surface of the twig, whence it would drop to the ground, but with the ventral spines inserted in the aperture the egg can readily pass from the oviduct to the place prepared for it.

Description of the Larva. (Plate III, figs. 1–10.)

The largest specimen in my possession is 12 mm. in length. The head is typically Cicindelidan; that is to say, it is strongly chitinised, swollen and concave beneath, flattened above; the mouth-parts are prominent and point in an upward direction. The antennæ are short and four-jointed. There are two ocelli borne on each side of the head near the origin of the antennæ; the area surrounding these ocelli is much darker than the rest of the head and is somewhat inflated. The labrum is broad and transverse with a quadrangular projection from the middle of the front margin, flanked on each side by a tooth; this quadrangular projection is ridged and has a blunt tooth on each side. The mandibles are strong and curved, each bears a tooth on its inner margin at the centre; distad of this tooth the inner border of the mandible is grooved, proximad of it the inner border is sharp and trenchant. The maxillæ consist of a small *cardo*, a stout triangular *stipes*, bearing a two-jointed palp and a narrow *galea* almost equal to the palp in length and furnished with

like structures. The species of *Therates* that I took in Borneo were not, so far as I can remember, arboreal, and in these the ventral spines are very small indeed. The Australian genus *Distypsidera* is said to be arboreal and in this genus also the ventral spines are present.

a few strong spines (Plate III, fig. 3). The labium is cordiform, densely hirsute above and with a pair of short two-jointed palps; the anterior angles of the basal joints of these palps are spiniform beneath and the tip of the apical joints is beset with numerous sensory pits (Plate III, fig. 4).

The body consists of 13 segments and is seen at once to differ from that of a typical Cicindelid larva by the absence of a marked sigmoid flexure and by the absence of large dorsal tubercles armed with strong hooks on the eighth segment. The *Collyris* larva in fact "fits" its burrow much better than does the *Cicindela* larva, it is thus able to brace itself at the top of the burrow without pronounced curvature of the body; the walls of its burrow being of a denser and harder texture than sand or earth accounts for the absence of long hooks on the eighth segment. The prothorax is as broad as the head; the pronotum is trapezoidal with rounded posterior angles and is strongly chitinised. From the mesonotum backwards to the eighth segment, the segments increase in breadth. The eighth segment is swollen dorsally forming a hump and the hump carries two curved series of small hooks, each series being composed of three hooks; the hooks are of a rather peculiar shape, which can best be understood by a reference to the Plate (fig. 5). In addition to the hooks are numerous stout setæ; both hooks and setæ are directed forwards. The three segments immediately behind the eighth are slightly narrower than it; the twelfth segment is much narrower and shorter and the thirteenth segment is small and sucker-like with six short spines and numerous fine setæ on its posterior margin. Segments 4 to 12 bear on each side in a dorso-lateral position a mamilliform tubercle furnished with three setæ, and a minute mamilliform tubercle with two setæ occurs on the ventral surface of these segments. These tubercles and setæ together with the dorsal armature of the eighth segment doubtless serve to brace the larva in its burrow.

Of the legs the following parts can be distinguished:—femur, tibia and tarsus. In the second and third pairs the femur is flattened and plate-like, with rounded angles; the tibia is rather slender, about two-thirds the length of the femur and with some setæ along its lower border and at its distal end; the tarsus consists of three joints, the terminal hook or claw being included as one joint; the first or basal point is ringed with setæ, the second has some setæ and, in addition, on its outer aspect a blunt tooth (Plate III, fig. 7). The first pair of legs is very different in shape; the femur is flattened and triangular with a row of setæ along its outer aspect; the tibia is short and very stout, broader distally than proximally, its lower anterior angle is produced to form a strong and acute tooth with

secondary teeth on the upper border, a small blunt tooth also occurs at the upper anterior angle on the outer aspect; the tarsus is triangular, the basal joint is almost as broad as long with a blunt tooth on its outer aspect, the second joint also is furnished with a tooth on its outer aspect and both joints are beset with setæ (Plate III, fig. 6). The second and third pairs of legs are carried with the femora straight out from the body, the tibiæ bent upwards; no doubt they brace against the sides of the burrow and serve to steady the larva when it catches some large or active insect. The front legs are plainly adapted for excavating the soft core of the twig in which the larva lives.

In conclusion I would beg to express my thanks to Dr. Sharp, F.R.S., Canon W. W. Fowler, and Mr. V. E. Shelford of Chicago University, for the kind help and useful criticism that they have offered me in the preparation of this account of a most interesting insect.

Explanation of Plate III.

[*See Explanation facing the* Plate.]

ADDENDUM.

After the foregoing account went to press, I received from Dr. D. Sharp a letter sent to him from Hongkong by Mr. F. Muir, in which Mr. Muir announces the discovery by himself and Mr. J. C. Kershaw of a wood-boring Cicindelid larva. Mr. Muir writes that the burrow "runs up the stem, the entrance being at the lower end. It [the larva] waits with its head at the entrance of the burrow and whenever an ant or a fly crawls up the stem within reach it quickly darts out its head and catches its prey." Apparently only one specimen was secured, and this, with the piece of wood containing the burrow, Dr. Sharp has kindly handed to me for examination. The larva is larger than that of *Collyris emarginatus*, measuring 12 mm. in length, but it can, I think, be referred to the genus *Collyris* without much doubt. There are only two pairs of ocelli; the legs are very similar in appearance to those of *C. emargi-*

natus; the eighth tergite bears on each side three small forwardly-directed hooks and its posterior margin is fringed with setæ; the terminal segment is armed on its posterior margin above with eight short spines arranged in two groups of four on either side of the middle line. In fact, such differences as exist between the two larvæ may be regarded as specific rather than generic. In one feature the Hongkong larva differs markedly from *C. emarginatus*; the metathorax is bent down almost at a right angle to the mesothorax and the first abdominal and succeeding segments are again bent up at an acute angle to the metathorax, thus producing a very sharp flexure of the body in this region. I cannot be sure, however, that this is not due to the undue contraction of the specimen after being placed in alcohol. The burrow is 24 mm. long and about 3·5 mm. in diameter, it has been formed by the excavation of the central medulla of pith; the affected part of the stem is dilated, being 7 mm. in diameter, whereas above and below the burrow it is only 4 mm. in diameter. This, I expect, is a pathological result of the injury caused by the larva. I have observed something very similar in the stems of a herbaceous plant tenanted by ants, that I found at the foot of Mt. Penrisen in Sarawak.* The consequence of this dilation of the stem is, that the burrow itself is relatively of much greater diameter than that made by the *emarginatus* larva; the dilation appears to be caused, not by a thickening of the wood, but by the expansion outwards with concomitant thinning of the walls, just as a bulb may be blown in the middle of a glass tube. It would be interesting to learn if this dilation of the stem and expansion of the burrow occurs synchronously with the growth in size of the larva. Mr. Muir's observation that the larva, when seizing its prey, rushes a short distance out of its burrow, is of considerable interest in connection with the fact that the entrance to the burrow cannot be enlarged by the larva as it increases in size. The entrance to the burrow of a *Cicindela* larva is a miniature pitfall, the head of the larva being the bottom of the trap; when an insect stumbles into the pitfall it is seized and the captor falls down to the bottom

* If this interpretation is correct it lends considerable support to the view that the enormous swellings on the stems of myrmecophilous plants of the genera *Myrmecodia* and *Hydnophytum* originated as pathological responses to irritant stimuli.

of its burrow with its prey. It is necessary that the head of the larva should always fit more or less accurately the entrance to its burrow, but the same necessity does not arise in the case of the *Collyris* larva, for here the burrow is a hiding-place or lair from whence the animal emerges to capture its prey; so long as the entrance to its lair is not too small it cannot particularly matter what size it is.